

Geomorphology Report on Coastal Erosion at the Detention River Estuary, Hellyer, North West Tasmania



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Executive summary

The western bank of the Detention River estuary has in the last few years suffered erosion owing to the active estuarine channel meandering to the west. The main estuarine channel was located in the centre of the estuary from 1971 to 1997 at least, and has moved west after 2004 following increased sand deposition in the mouth. Human activity in the area is further exacerbating the erosion problem, and fallen trees also contribute to sediment erosion. Erosion at this site is not primarily caused by rise in sea-level, though it exemplifies the types of impacts that widespread coastal areas in Tasmania will experience in coming decades.

Recommendations to mitigate this erosion problem must be agreed by stakeholders involved, and options include restriction of public access, further removal of large woody debris at the base of the erosion scarp, increasing the sheer strength of the erosion bank by control of runoff and revegetation, and boat wake restriction in the estuary. These actions would all decrease erosive forces at the site. Subject to EIA approval and supervision by a hydraulic engineer this geomorphologists' report can also support the option of reconstruction of the central estuary main channel at its position around 1988 to 1997, to relieve flow at the erosion site. This might include the option of subsequent beach replenishment of the erosion site, though involving no hard structures. Further investigation particularly including GIS analysis and site monitoring should also be carried out.

List of Contents

1.0 Background	3
2.0 Methods	5
3.0 Results	6
3.1 Aerial Imagery	6
3.2 Site Observations	12
3.3 Transect surveys and sediment analyses	13
3.3.1 Transect 1	13
3.3.2 Transect 2	16
3.3.3 Transect 3	19
4.0 Discussion	22
4.1 Causes of the Erosion	22
4.2 Recommendations	24
4.2.1 Restriction of public access	24
4.2.2 Further removal of large woody debris	24
4.2.3 Increasing the sheer strength of the erosion bank	24
4.2.4 Boat wake restriction	24
4.2.5 Relocation of the estuary main channel	25
4.2.6 Further investigation and monitoring	25
5.0 Conclusions	26
6.0 Acknowledgements	26
7.0 References	27

1. Background

Estuaries in NW Tasmania are characterised by both high tidal exchange and highly seasonal river flows (Hirst et al., 2007). The Detention River estuary Detention River is a small mesotidal river estuary (Crawford & White, 2007), and enters Bass Strait at Hellyer Beach on the Northwest coast of Tasmania (Short, 2006; Hirst et al., 2007). The Detention catchment has an area size of 152 km² (Hirst et al., 2007) developed upon Precambrian sediments, metasediments and tertiary Basalt (Edgar et al., 1999). The catchment is in a relatively unmodified condition as it is for the most part surrounded by State Forest, with only 19.7% of land around the catchment cleared as at 2006 (Hirst et al., 2007). Using physical and ecological, population, land use and conservation significance attributes Edgar et al. (1999) classified the Detention River estuary as holding moderate conservation significance values. In spring 2004, large scale clearing of riparian vegetation took place on the eastern bank of the upper reaches of the Detention estuary (Hirst et al., 2007).

Hellyer Beach, to the west of Detention River, is a 2.5 km beach that faces north-northeast and has a spring and neap tidal range of 2.6 to 2.0 m (Short, 2006). Long-shore movement of sediment along the beach is generally from the west to the east due to ocean swells predominately from the southwest (Bugg, 1990) and the spit at the mouth of the estuary indicates this predominant longshore drift. The beach is classified as dissipative based on the presence of bars and troughs, wave type and the low angle slope (Short, 2006). As a result of Late Holocene coastal progradation during stable sea-level, Hellyer beach is backed by a series of ridged barrier dunes in which the township of Hellyer has been built. LiDAR data demonstrates 7 shore parallel dune lines to the west and the east of the Detention Estuary mouth (Chilcott, pers. comm.), though the area of the township is unclear perhaps owing to land development.

Shore sediments of this coastal section are highly quartzose with little carbonate, and estuaries are filled with marine sand (Davies and Hudson, 1987). Quartz is generally derived from quartzite and other arenaceous rocks of Pre-Cambrian and Cambrian age, which frequent the Western Bass Strait coastal catchments (Davies and Hudson, 1987; Davies, 1978). The area is sheltered from the prevailing westerly swell entering Bass Strait, as well as majority of local gale force winds coming from the northwest. Therefore wind and wave energy is low (Davies & Hudson, 1987; Davies, 1978).

This small coastal town borders the western side of Detention River (Figure 1) with annual rainfall average in the catchment area is around 1286 mm and a mean daily maximum temperature of 16⁰C (Bureau of Meteorology, 2010). As with most coastal towns a section of Crown Land was reserved between the privately owned properties and Detention River, however over the last few years it has been noticeably eroding towards houses close to the shore. Residents in the area have stated that over the last decade and particularly within the last few years they have watched the lower estuary channel meander closer toward the township of Hellyer causing erosion of the beach and Crown land moving toward private properties potentially threatening infrastructure (Figures 2 and 3) (ABC News, 4 March 2010; Heathorn, 2008; 2009).

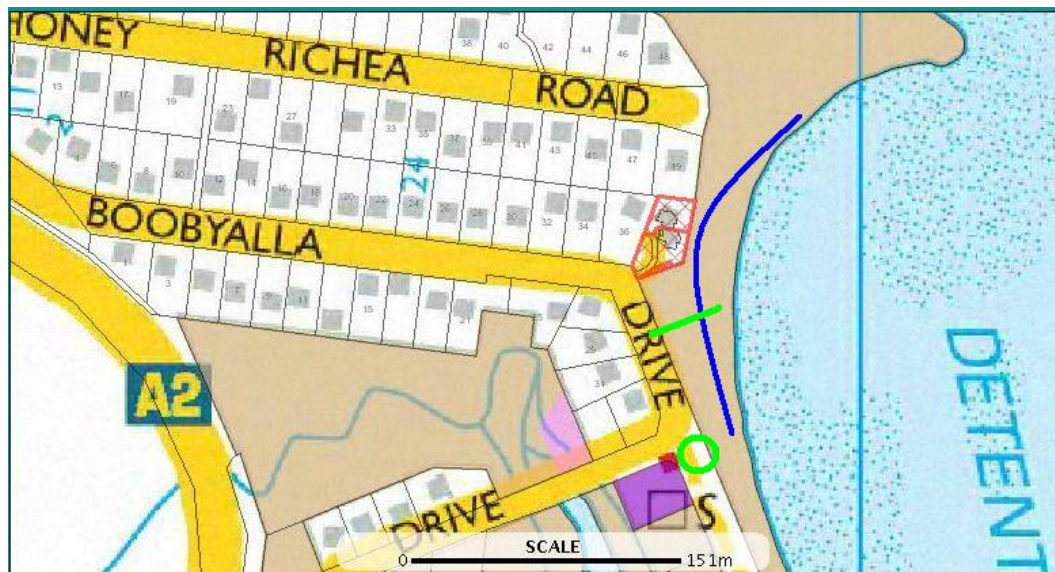


Figure 1: Map of erosion site (from Crown Land Services, 2010).

Key: Blue line: approx. location of erosion bank; Brown: Crown Land; White: Freehold. Red: Most affected properties; Purple: Fire station.



Figure 2: From the Detention River foreshore a look at the vertical bank erosion outside the property of Unit 1 and 2, 38/40 Boobyalla Drive, Hellyer (ABC News, 4 March 2010).



Figure 3: Unit 1 and 2, 38/40 Boobyalla Drive, Hellyer, in August 2004 (Heathorn, 2009).

Local residents Brian and Alison Heathorn have stated that the Detention River channel has over recent years progressed westwards, causing significant erosion of the dune bank on Crown Land in front of their property (Heathorns' statement to the Environment, Resources and Development Committee, 2008).

This report aims to investigate the influences and causes of bank erosion on the western side of the Detention River and provide options for future management of the area.

2.0 Methods

Historical aerial photography provided by DPIPWE Crown Land Services were visually compared, and statements from local residents on the chronology of the erosion problem cross correlated.

An investigation of the erosion site and its context was made on 23rd April, 2010 around S 40° 52.179' E 145° 26.397'. Three transects perpendicular to the shore line were surveyed using Leica NA270 automatic levels.

Sediment samples the surface exposure were taken from along each transect and from strategic locations such as the transect scarp, dunes behind, the high water mark directly in front of the scarp, as well as the seaward beach and NW point. Samples were transported back to the University of Tasmania, Launceston for laboratory analysis. Grain size was determined using standard sieve methodology, sieve sizes included 3.36 mm, 0.84 mm, 0.42 mm, 0.25 mm, 0.149 mm, 0.062 mm. Statistical analysis was carried out based on cumulative frequency curves. This included a measure of degree of scatter, a measure of degree of symmetry and Kurtosis.

Particle shape was determined using a roundness and sphericity chart (Nichols, 2009). Mineral composition was determined using scanning microscopes. Hydrochloric acid was then added to a portion of sediment from each sample to examine carbonate content. A percent value was assessed from degree of dissolution.

All transects were perpendicular to the erosion shoreline, and were located from south to north as follows:

Transect 1: from the property boundary of 49 Honey Richea Road in line with it's chimney, facing due east.

Transect 2: from the telephone pole seaward of 49 Honey Richea Road.

Transect 3: towards the seaward end of the erosion site, crossing the dunes to the beach.

Figure 4 shows the relative locations of transects 1 and 2.



Figure 4. Relative locations of Transects 1 and 2.

3.0 Results

3.1 Aerial imagery

Crops of the aerial imagery for the years 1968, 1971, 1988, 1997 and 2007 are shown in Figures 5-8 and 10. These are described in sequence over time. It should be noted that orthorectification and GIS analysis of these images could be carried out as an improvement to any interpretation here, and tidal state at the time of each image could also be incorporated into an improved analysis of these sources.



Figure 5. Detention Estuary mouth in 1968 (from DPIPWE image 1968-507-9).

Figure 5 taken in 1968 shows the main estuarine channel to the west, with greater width and it seems depth as demonstrated by darkness of colour than a smaller channel to the east. In the centre of the estuary mouth to the south of the NW sand spit is a sand bank. Later images will be described relative to this baseline.



Figure 6. Detention Estuary mouth in 1971 (from DPIPWE image 1971-582-67).

Figure 6 taken in 1971 shows the main estuarine channel in the centre, with greater width and it seems depth as demonstrated by darkness of colour than a smaller channel to the west. This central channel passes to the west of a sand bank in the centre, and relative to 1968 has caused erosion to a sand spit to its south east. The estuarine channel in the east seen in the 1968 photograph seems to have closed with sediment deposition.



Figure 7. Detention Estuary mouth in 1988 (from DPIPWE image 1988-1098-116).

Figure 7 taken in 1988 shows the main estuarine channel in the centre, with greater width and it seems depth as demonstrated by darkness of colour. The central sand bank visible in the 1968 and 1971 images seems to have gone. There has been further erosion to the sand spit to its south east, but to the north east there has been continued beach progradation. The NW sand spit point seems to have lost vegetation from its end and recurved south relative to the 1971 image. On this 1988 photograph there does not seem to be a deep channel adjacent to the erosion site problem area to the west, with predominant flow through the centre of the estuary.



Figure 8. Detention Estuary mouth in 1997 (from DPIPWE image 1997-1266-121).

Figure 8 taken in 1997 shows the main estuarine channel in the centre, in a similar location to the 1988 image, though perhaps moved to the west. The sand spit on the northwest point of the mouth seems to have shortened (eroded). The prograding beach on the east side of the estuary has reworked into a more defined spit in the centre of the bank, and a small sand bank in the centre seems to have developed at the tip of this. On this photograph there does not seem to be a deep channel adjacent to the erosion site problem area to the west, predominant flow is through the centre of the estuary.

A local resident Mrs Ruth Heathorn (2009) stated that in January 2003 the main estuary channel was running on the eastern side of the estuary with an approximately 30 m foreshore outside the houses on the western shore, shown in Figure 9. The main channel seems here to be perhaps moved west from the 1997 aerial image.



Figure 9: Photo dated January 2003 looking towards the NW point, from the estuary foreshore near the units, showing the Detention River channel in the background (Heathorn, 2009).



Figure 10. Detention Estuary mouth in 2007 (from DPIPWE image 2007-1420-212).

Figure 10 taken in 2007 shows the main estuarine channel has moved back to near its position in 1968 along the western bank of the estuary mouth, with significant sediment deposits in the centre of the estuary mouth where there was a deep channel in the 1997 image. Parts of this previous central channel are still acting as flood runners at high water. In 2007 relative to 1997 seems to be more exposed pale sand in the mouth of the estuary, such as on the end of the western spit, and in the centre and east of the mouth. Pale sand is usually dry, being supratidal, though this can vary.

3.2. Site observations

The erosion scarp on the western side of the Detention river estuary extends from the access path from Boobyalla drive for about 300 m seawards. It varies in height from c. 1-3 meters owing to transecting through low dune ridges, and its base is on the margins of the main estuary discharge channel. Exposed paleosols are visible in the erosion scarp (Figure 11), indicating that this is a long established sediment deposit that is now under erosion. Tidal debris and erosion scours at the base of the scarp indicated that tidal currents have direct contact with the erosion scarp, which is of unconsolidated sand. There is no restriction of pedestrian access from either the road of the adjacent properties, and numerous footprints at the top of the scarp were visible on arrival.



Figure 11. Erosion scarp close to the Boobyalla Road access, showing palaeosols embedded, and tidal debris at the base.

Our visit was at low tide, demonstrating that a large sand bank (Figure 12) occupies the centre to east of the estuary mouth, as shown in the 2007 aerial photograph (Figure 10). The elevation of this appears to approach MSL, below which most flow is confined to the western channel. Observation of the estuarine tidal area south of the erosion site demonstrated that there is a large tidal volume to the south, which may direct significant flows down this more narrow tidal channel closer to the mouth.



Figure 12. View from the NW sandspit point with the erosion scarp on the right bank, showing relative elevation of the central sand deposit seen here above the channel water. This picture was taken about 11.30 am on 23.4.10 during a falling tide to reach a low of 0.61 m at 12.57 pm.

The Hellyer Beach frontage with Bass Strait shows some minimal signs of erosion, with some limited undercutting of foredunes, particularly at the spit point to the west of the Detention River estuary.

3.3 Transects surveys and sediment analyses

3.3.1 *Transect 1*

Transect 1 initiated from the property boundary of 49 Honey Richea Road in line with its chimney, facing due east (Figure 4). The total distance of transect 1 as shown in figure 13 covered 23.55 m, and was analysed by the background group in Figure 4. The main scarp face had a total fall of 1.24 m. The micro-cliff had a fall of 0.755 m. Vegetation at the top of the cliff consisted of sedges and ferns including bracken and poa grass. No vegetation was present at the base of the scarp, only a small tuft of weed was present on the top of the micro-cliff. The slope from the base of the micro-cliff to the waters edge is steep at 48.1°.

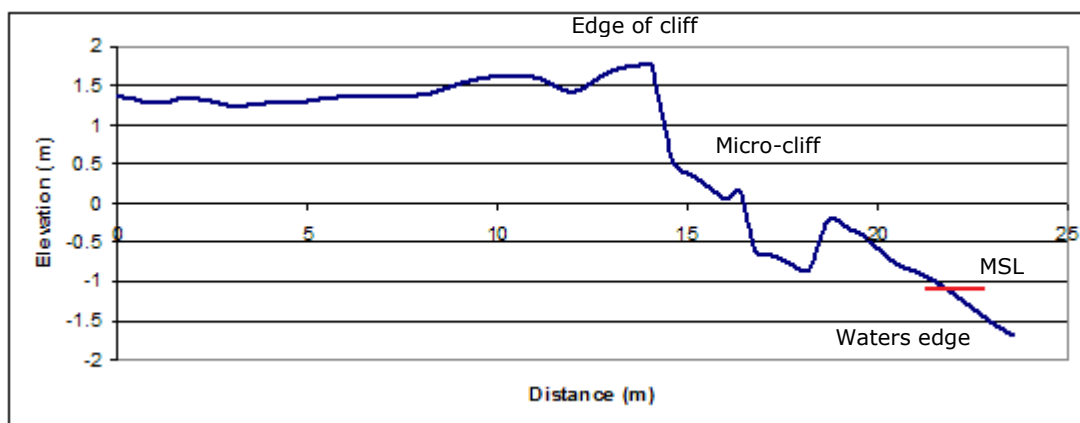


Figure 13. Cross sectional profile of transect 1 showing main features with mean sea level (MSL).

Particle analysis showed grain size to be similar throughout the locations sampled, shown in Figure 14. Grain size 0.149 mm was the dominant particle size which is classified as fine sand based on dimensions of sand found in Nichols (2009). The estuary corner had the most very fine sand (0.062 mm). The transect waters edge had the least proportion of fine sand and the highest proportion of medium sized sand. The transect scarp had lowest proportions of medium and coarse sand, with 82.05% of fine sand.

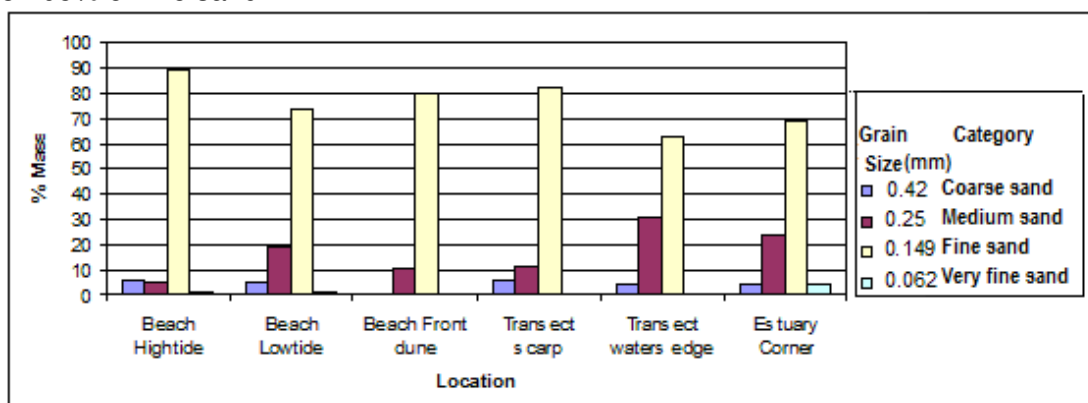


Figure 14. Percentage particle grain size for transect 1.

Table 1 shows the cumulative frequencies of the grain size analysis as well as statistical tests that are based on the cumulative curve as shown in Figure 15. The degree of sorting found only the beach at high tide to be very well sorted (0.23). The estuary corner, the beach front dune and transect waters edge were also very well sorted (0.3), while the remaining locations had a value 0.54 which correspond to moderately well sorted sediment.

The degree of symmetry found the beach front dune to be the only location strongly skewed towards fine particles. The remaining locations were all strongly skewed towards coarse particles.

The shape of the grains varied between sub-rounded and well rounded (see Table 2). The beach was the only area where well rounded grains were present. Within the estuary, grains were sub-rounded. The mineral composition showed quartz to be dominant. Halite, silica and mica were minor minerals also found in the analysis. The carbonate content revealed the transect scarp and waters edge to have only minor quantities of carbonate compared with the beach zones and further into the estuary.

Table 1. Sediment grain size cumulative frequency for samples on transect 1.

	<i>Beach Hightide</i>	<i>Beach Lowtide</i>	<i>Beach Front dune</i>	<i>Transect scarp</i>	<i>Transect waters edge</i>	<i>Estuary Corner</i>
3.36			0.36			
0.84		1.76	0.36		0.75	
0.42	5.66	6.93	0.99	5.83	5.53	3.96
0.25	10.69	25.97	11.24	16.89	36.41	27.51
0.149	100.11	99.59	90.70	98.94	98.99	96.92
0.062	101.52	100.66	91.50	99.81	99.38	101.77
<i>Degree of Sorting</i>	0.23	0.54	0.30	0.54	0.49	0.30
<i>Degree of Symmetry</i>	-0.5	-1	0.52	-1.40	-1.40	-0.56
<i>Kurtosis</i>	0	0.457	0	0	0.457	0.228

Note: Cumulative percent of sieve mass does not total 100% in all samples. This is due to minor errors in methodology of sieve sampling, with minor sediment losses experienced during weighing. These variations are not regarded as significant.

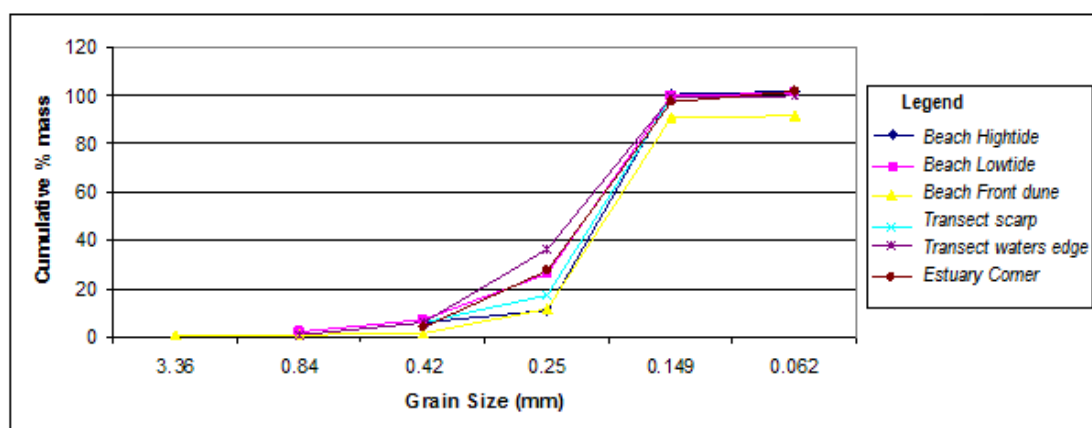


Figure 15. Cumulative frequency curve of grain size at transect 1.

Location	Shape	Composition	Carbonate %
<i>Beach Hightide</i>	sub rounded	quartz dominant, mica, halite, silica <1%	20
<i>Beach Lowtide</i>	well rounded	quartz dominant, mica, halite, silica <1%	10
<i>Beach Front dune</i>	well rounded	quartz dominant, silica, mica, >20% mica	35
<i>Transect scarp</i>	sub rounded	quartz dominant, silica, mica, 5% halite	<5
<i>Transect waters edge</i>	sub rounded	quartz dominant, 10% halite, mica	<1
<i>Estuary Corner</i>	sub rounded	quartz dominant, mica, halite	>45

Table 2. Shape, mineral composition and carbonate content for transect 1

3.3.2 Transect 2

This transect was measured by the foreground group in Figure 4, with a backsighting toward the NW to a telephone pole to act as a secure benchmark for future monitoring of change. The beach profile is illustrated in figure 16, showing the water level at low tide, high tide mark, locations of sediment samples, and the time and date that the transect was recorded. This beach profile has a total fall of 385.5 cm over a distance of approximately 15.8 m, giving a gradient of 0.244.

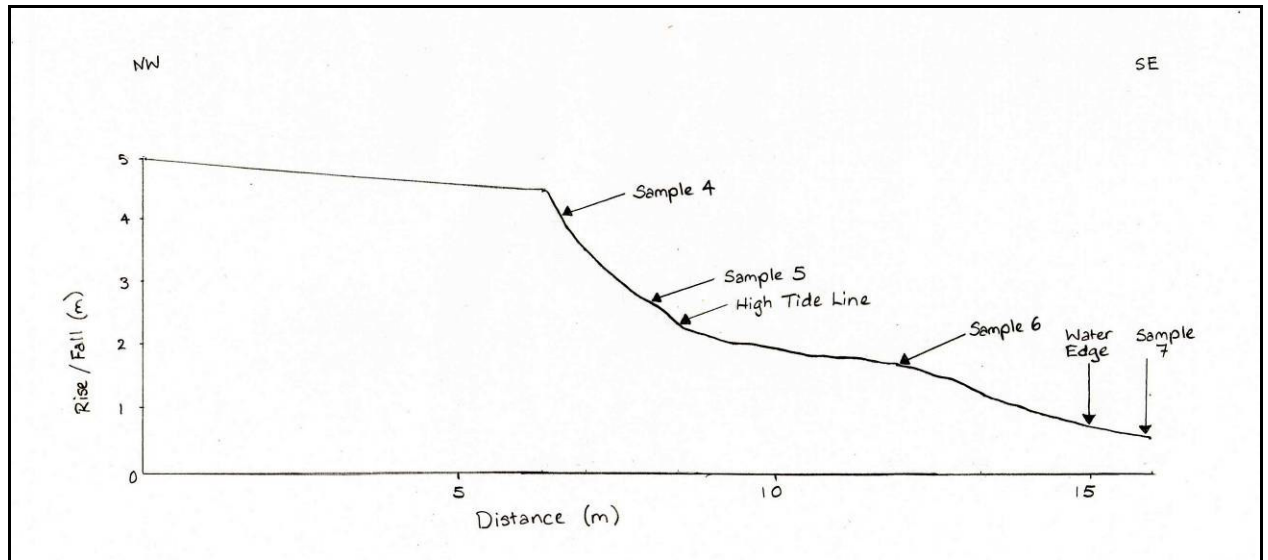


Figure 16. Profile of transect 2 at Detention River estuary, Hellyer. Transect measurements taken 23rd April 2010 around 1:15 pm.

Table 3: Grainsize analysis of sediment samples from transect 2 and the beach.

Phi size	2	1.2	0.5	0.25	0.125	0.063	<0.063	Total
Estuary – below high tide	0.28 (sticks organic matter)	0	0.48	76.38	103.02	17.57	0	197.73
Estuary – dune wall	0	0	2.24	60.78	122.62	4.27	0	189.91
Estuary – scarp/erosional face	0	0	9.73	75.50	98.38	21.02	Small amount	204.63
Estuary – river sample	0	1.00	13.05	64.17	102.7	10.80	0	191.72
Beach – high tide/strandline mark	0	0	1.53	29.00	153.05	14.33	0	197.91
Beach – near low tide mark	0	0.33	9.96	40.44	142.14	5.8	0	198.67
Beach dunes	(roots and organic matter)	(roots and organic matter)	2.4	57.80	112.1	26.0	Small amount	190.3

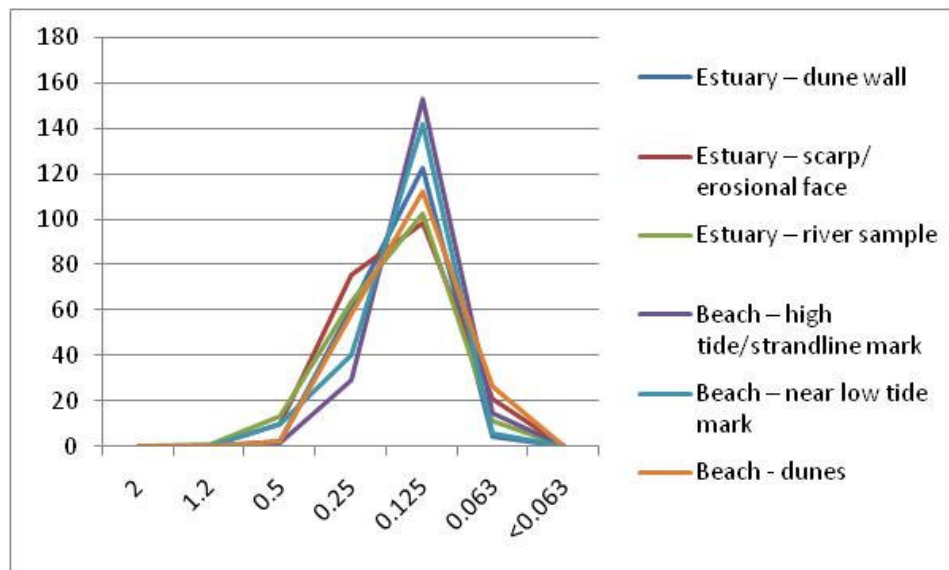


Figure 17: Sediment Grainsize analysis, transect 2.

Results for the sediment samples are shown in Table 4. The results show that the dominant mineral is quartz. Other minerals present are silicate, mica and halite. Carbonate is present but only in the beach high tide area and the sample taken at the mouth of the estuary. The remaining sample sites had little or very small amounts of carbonate present.

	Estuary – below high tide	Estuary – dune wall	Estuary – scarp/ erosional face	Estuary – river sample	Beach – high tide/ mark	Beach – near low tide mark	Beach – dunes
Comp- osition	Quartz- dominant, ~5% carbonate	Quartz- dominant, 25-30% carbonate	Quartz- dominant, 5-10% carbonate	Quartz- dominant, 20% feldspar, 30% carbonate	Quartz- dominant, minor feldspar (10%), 20% carbonate	Quartz- dominant, 20% carbonate, minor organic matter	Quartz- dominant, minor feldspar (10%), 30% carbonate
Round- ness	Subangular to sub- rounded	Sub- rounded	Sub- rounded	Quartz: subangular – subrounded Feldspar: subrounded – rounded	Sub- rounded	Sub- rounded	Sub- rounded

Table 4. Particle composition and roundness for samples on transect 2.

3.3.3 Transect 3

Transect 3 was analysed by the group photographed in the frontispiece picture on the cover page, and was the most seaward transect near the northern margin of the erosion area (Figures 18 and 19).

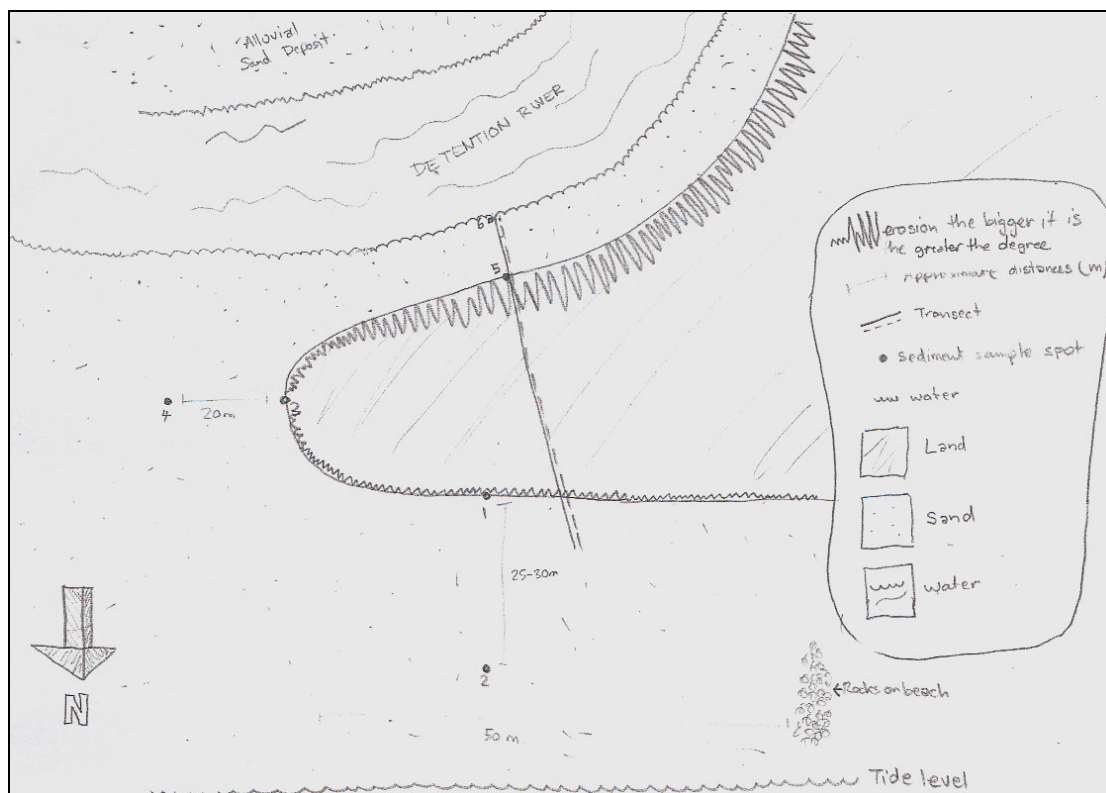


Figure 18. Plan sketch map of the location of transect 3, and sediment sample locations.



Figure 19. Erosion on the western bank of Detention River at the beginning of transect 3. The transect ran approximately 1 m to the north-eastern side of a sapling that can be seen in the top left hand corner of the photo.

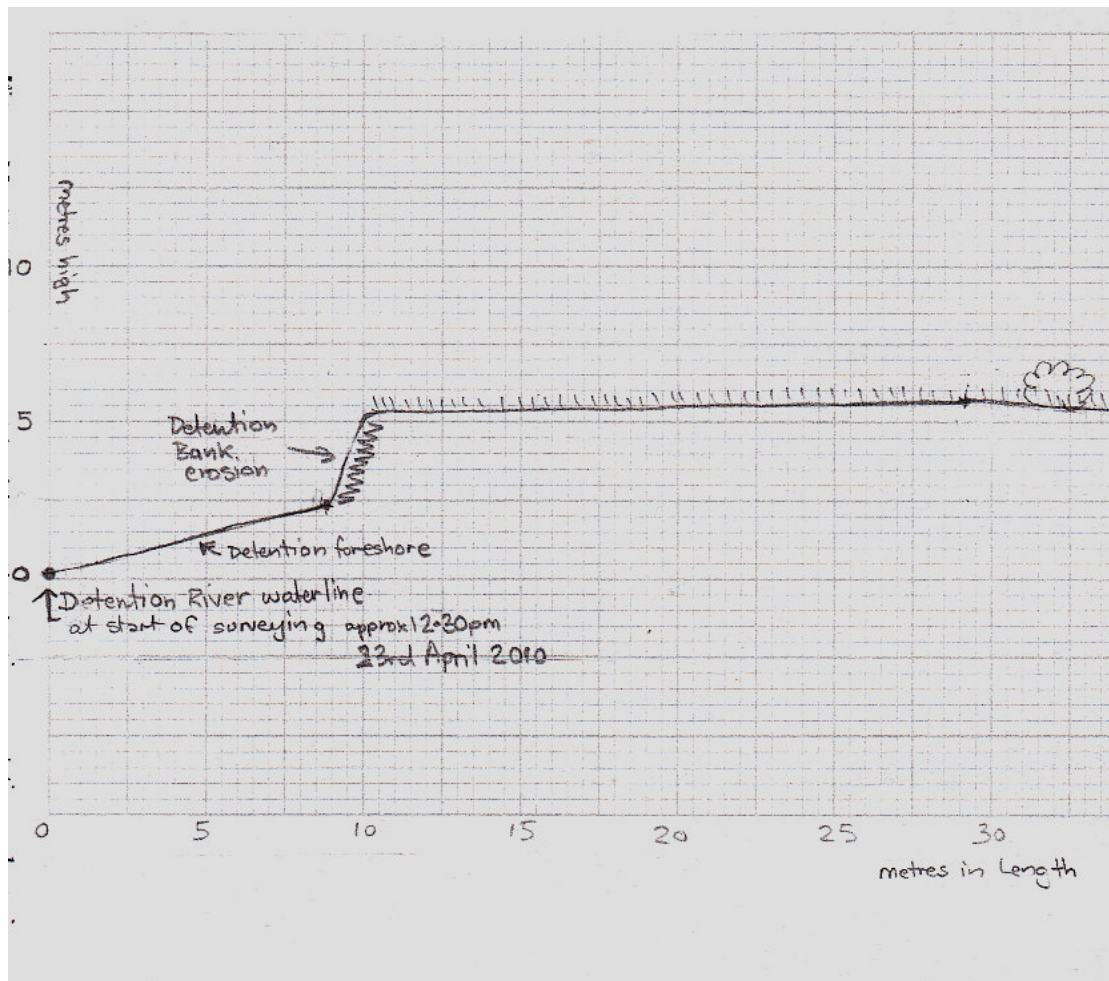


Figure 20. Cross sectional profile of the southern half of transect 3.

Table 5 shows the grainsize distribution values for each sediment sampled on transect 3 (located in Figure 18), with the results shown in Figure 20. The dominant trend displayed in the graph indicates that there is a wider grainsize variation in the estuarine sediments relative to the beach sediments, meaning that they are less well sorted than those sampled on the beach.

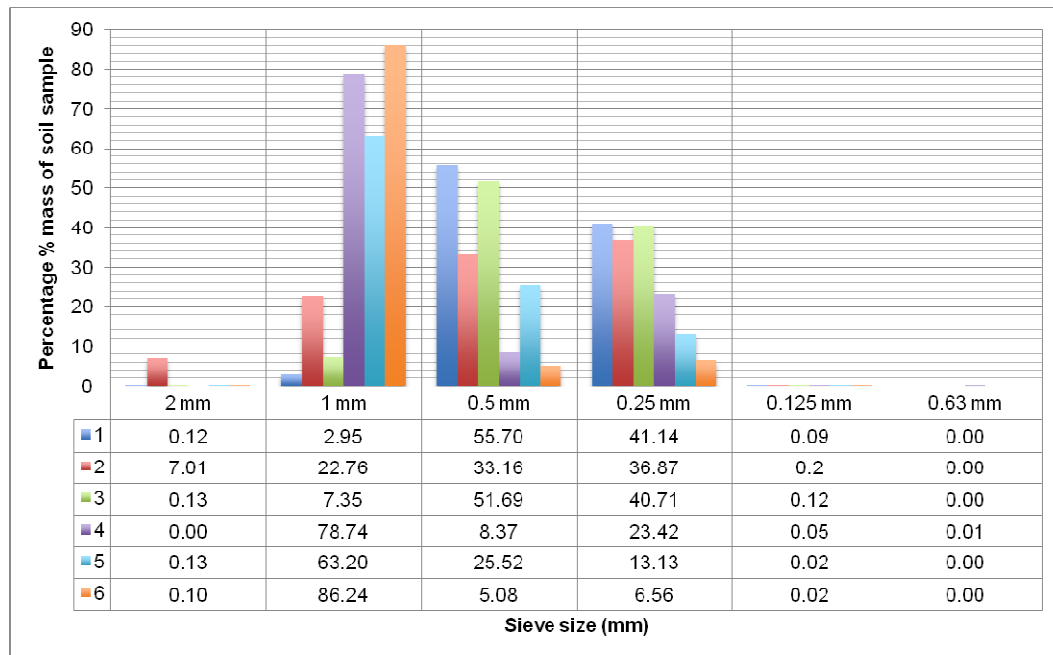


Table 5: Frequency distribution histogram comparing sediment samples from transect 3, values are in grams.

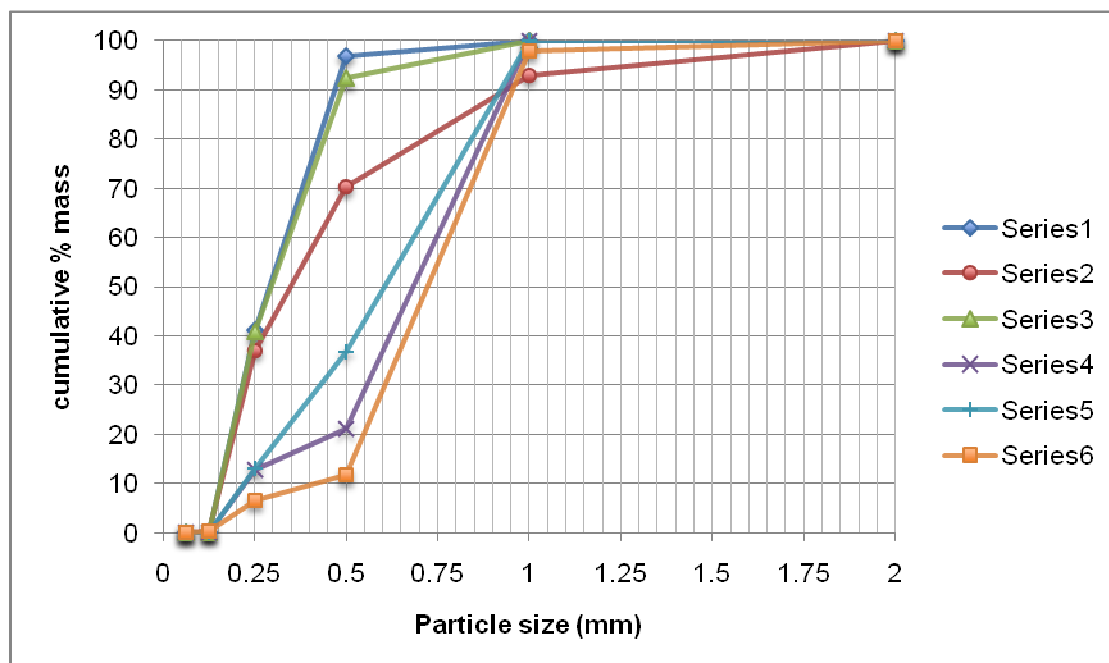


Figure 21. Cumulative frequency curve comparing all sediment samples (key = series 1 is sample 1 etc.)

Samples 4, 5, 6 and 7 were collected along the transect, and Table 6 shows the degree of rounding of particles was consistent both between and within the two primary sites of sampling. The primary differences between the beach and the estuary are found in the sediment composition. Samples collected on Hellyer Beach (1, 2 and 3) do not contain notable amounts of feldspar or lithic fragments, while each sample obtained from the estuary (4, 5, 6 and 7) contained at least minor amounts of feldspar. No significant trend can be found in the amount of carbonate at each site.

Table 6: Results for each sediment sample from transect 3 in regard to colour (Munsell soil colour), particle shape (Powers, 1953) and dominant mineral composition through observation using 1M HCl.

Soil Sample	1	2	3	4	5	6
Munsell soil colour	8/3 10YR	6/3 10YR	8/3 10YR	8/2 10YR	7/3 10 YR	7/2 10YR
General Particle shape	Sub-angular	Sub-rounded	Sub-rounded	Sub-rounded	Sub-rounded	Sub-rounded
Dominant mineral composition	Carbonate dominated	Quartz dominated	Quartz dominated	Carbonate dominated	Carbonate dominated	Quartz dominated

4.0 Discussion

4.1 Causes of the erosion

Comparison of the aerial imagery in section 3.1 and residents' photography of the mouth of the Detention River estuary indicates that between 2003 and 2007 the mouth of the estuary became blocked by sand deposits, moving the active channel to the west. B. Heathorn (2008) described to the Environment, Resources and Development Committee, that the channel movement to the west occurred during periods of more easterly winds combined with high tides in the previous 3 years, but not large storms. Sediments may also have been sourced from catchment disturbance and deposition in the low gradient estuary. In spring 2004, large scale clearing of riparian vegetation took place on the eastern bank of the upper reaches of the Detention estuary (Hirst et al., 2007).

The Hellyer Beach frontage with Bass Strait shows some small signs of erosion, but this is minimal compared with the 300 m section inside the Detention River estuary described in section 3. This indicates that the erosion problem is due to local factors, it is not primarily caused by relative sea level rise of the last century as this would show more on the ocean facing beach than inside the estuary. Global mean sea level has been rising, from 1961 to 2003, the average rate of sea level rise was 1.8 ± 0.5 mm yr⁻¹ (Bindoff et al., 2007) which also occurred in Tasmania during the last century (Pugh et al., 2002). Most beaches worldwide show evidence of recent erosion but sea-level rise is not necessarily the primary driver (Nicholls et al., 2007). Erosion can result from other factors, such as altered wind patterns (Pirazzoli et al., 2004; Regnaud et al., 2004), or short-term disturbance such as a storm (Bindoff et al., 2007; Ellison, 2008).

The annual rainfall average in the catchment area is around 1286 mm. In 2006 the rainfall was 919.6 mm; uncharacteristically low for the area (Bureau of Meteorology, 2010). In spring 2005, flows appeared to be higher than the mean, however, in 2006 with low rainfall winter flows in June and August 2006 were up to 50% lower than the 30-yr mean (Hirst et al., 2007). This may have reduced flushing of the estuary mouth during the period of sandbank build-up inside the mouth.

From the erosion scarp, all three transects showed unconsolidated sand with a steep angle, far greater than the 30° threshold at which the shear strength of the site is reduced (Nichols, 2009). All transects demonstrate concave profile typical of eroding beaches, especially with a microcliff present (Bird, 2000), as shown in Figures 13, 16 and 20.

The sediment grain size analysis showed that all of the samples at transects 1 and 2 are predominately close to 0.125 mm grain size, putting them in the fine sand category. Coarser sand was found at the base of the erosion scarp, where sediment was also more rounded and more sorted. This indicates strong water flow at the base of the erosion scarp, with preferential removal of finer sand brackets, while higher on the erosion scarp sediment was rather moderately well sorted. Better sorting is indicative of higher energy wave conditions (Bird, 2000: 95). However the degree of symmetry revealed the beach front dune to be strongly skewed towards fine grains (see Table 1), while the remainder of the area was strongly skewed towards coarse grains. As coarse grained sand is less cohesive than fine grained sand (Nichols, 2009), it shows the scarp sediment is more vulnerable to erosion.

The mineral analysis showed that transects 1 and 2 are both predominately quartz dominant, with very low carbonate, which is typical of the area (Davies, 1987; Davies and Hudson, 1987). Transect 3 at the seaward margin of the erosion site showed more carbonate presence in dune sand above the erosion scarp and also on the open beach, while the waterline of the transect below the erosion scarp was quartz dominant. The transect 2 group also found carbonate dominance from a sample from the beach (Table 3), relative to quartz dominance inside the estuary.

Channel meandering is a natural process of estuaries, owing to alternating ebb and flood currents that deposit bars in the intervening calmer zones of water (Bird, 2000). Over time the bar increases in size to the point of redirecting the main flow of water, as was the case in Shoalhaven discussed by Umwelt (2005). The evidence provided in this study shows similar channel meander. From the results, while it can be deduced that the increased level of erosion is caused from a build up of sediment in the estuary mouth over the last few years, causing the active channel to move to the west, however human activity is a contributing factor. There was ample evidence on arrival of footprints and disturbance around the top of the erosion scarp, with no control of human access. Other vulnerable sections of eroding dunes in Tasmania such as Turners Beach have as a result of active Coastcare groups limited human access to eroding sites, constructed walkways, and replanted coastal vegetation to increase resilience of erosion (Ellison et al., 2002).

Human disturbance reduces the shear strength of consolidated sediment banks, and makes these less resilient to erosive forces. The impact of waves and currents on the erosion site is also increased by large woody debris (fallen trees) when these are moved against the erosion cliff at high water. During high tides, the large woody debris would promote further sediment disaggregation by contact with the bank sides. Heathorn (2008) indicated that these fallen trees have been at the site since before that time, and the loss of this dense vegetation increased human access. These fallen trees were partly removed earlier this year following advice from the lead author of this report.

4.2 Recommendations

Management options at this site will be subject to discussion and agreement by Local and State Government with local residents, and several options are presented from this preliminary geomorphological investigation.

Construction of a wall at the erosion site, using concrete, rocks or sand bags is not an option recommended by this report. Use of hard surfaces in a soft sediment environment subject to water erosion results in a worsening of the problem, with scour impacts in front, at the ends and behind the wall by water getting behind the “protection” and causing even worse erosion (Komar, 1998: 528; French, 2001: 60) . Sea walls also deflect water energy further along the section and may erode parts that are currently stable. Basically, sea walls do not address the sources of the erosion, while the below recommendations do.

4.2.1 Restriction of public access

There is substantial unrestricted access to the beach, particularly in front of the most affected properties where the vegetation on top of the dunes is being trampled by human activity and contributing to the erosion scarp continues to collapse. All access to the beach needs to be confined to one or two well constructed ramps / steps. The pedestrian traffic is clearly having an impact and the erosion site needs to be fenced off to restrict any further degradation. Until well constructed ramps or steps are complete, human access to the areas of high level erosion should be restricted by blocking access to the Boobyalla Drive pedestrian walkway. Pedestrians could be redirected to the northern beach while site protection and regeneration occurs.

4.2.2 Further removal of large woody debris

Large woody debris at the base of the erosion site has already been partly cleared relative to photographs available from earlier this year. Further removal of large woody debris will assist site stability. Such objects floating at high tide impact the erosion scarp to increase sheer stress, disaggregation and erosion rates. Remaining debris adjacent to the scarp along the beach below should be completely removed with care.

4.2.3 Increasing the sheer strength of the erosion bank

Sheer strength of slope materials is reduced by increased water content in sediment, and so site stability can be increased by restriction of water outflow from the properties above the erosion bank. This includes minimisation of irrigation, septic tank outflow and runoff from the property surfaces as well as the roads behind.

4.2.4 Boat wake restriction

Estuarine erosion by boat wakes has been identified as a serious problem in other estuaries in Tasmania (Bradbury et al., 1995), leading to introduction of low boat wake limits. Such wake waves can have severe erosive impacts on sediment banks of the estuary, and is thought to be a major cause of extensive erosion in the Tamar estuary (Sheehan and Ellison, 2007). Such erosive wakes are generated by both power boats and jet skis in excess of 10 knots in speed. While Heathorn (2008) did not believe that boat wakes were a major cause of erosion in the Detention estuary, a

formally signed restriction would certainly be a suitable precautionary action to reduce further erosion.

4.2.5 Relocation of the estuary main channel

There have been suggestions to change the course of the active channel (straightening) and not allow it to follow the west bank (Heathorn, 2008). This option would be expensive and may not be successful. A similar exercise was attempted at the Orford River mouth on the east coast only to have the estuary mouth revert to its previous path not long after. Further, this type of intervention may require an environmental impact assessment, and may have unanticipated impacts on aspects like biodiversity and water quality values.

Given these reservations, from a geomorphologists' perspective, the channel used to be located in the center of the estuary for a considerable period of time including 1971, 1988, 1997 and perhaps 2003 (Figures 6-9) with no obvious adverse impacts to adjacent beaches. Hence there seems to be no reason why the central channel through the estuary mouth should not be recreated at its former position as shown by the 2003 aerial image in Figure 8. This would relieve ebb water flow pressure on the western bank, as shown in Figure 12, as dredging the pre-existing channel will redirect the passage of water away from the erosion site. French (1997) acknowledges that dredging can change the ebb and flood tide directions and that the system naturally attempts to level out and fill the constructed channel. It is also an expensive option. Therefore such dredging should only be carried out with local supervision from a hydraulic engineer, who may also be able to advise on suitable relocation of the spoil. If this is used to fill in the base of the bank at the western erosion site, then the new channel must be open before this commences otherwise tidal flow will be blocked which may worsen erosion problems.

The full images of the 1997 and 2007 aerial photographs provided by DPIPWE both show ebb dominant deposition features at the mouth of the estuary. This would indicate that any dredging would be most precautionary to commence at the south of the sand bank and progress north, preferably working during falling tide and ceasing work during rising tide. This would prevent sediment washing further up the estuary, but a EIA should further investigate such possible impacts. Similarly, any fill added to the western erosion site is likely to be less hazardous if added from the south towards the north during falling tide, and should be carried out under supervision of a local hydraulic engineer.

As stated with reasons in section 4.2 above, inclusion of any hard structures in adding fill to the western erosion site is not a recommendation of this geomorphology report.

4.2.6 Further investigation and monitoring

This report is a preliminary study and its findings could be improved by further investigation of the situation.

Aerial photography in section 3.1 was merely by visual comparison of images, a more comprehensive analysis is needed using orthorectification of the images and comparison of change over time using GIS.

Following recommendations of section 4.2.3 a survey could be carried out of drainage from the Hellyer township and nearby properties to ensure that outflow to

the erosion site is prevented. This could include as analysis of any acid seepage from septic tanks that are close in the adjacent suburb, as this may dissolve and carbonate content in the dune materials and so disaggregate the site sediments further.

The three transects surveyed could provide a baseline for future monitoring if the surveys are tied to secure benchmarks. These were not available at the time of survey, but could be relocated using the temporary benchmarks described in section 3.3. Re-survey of these transects in future will allow a quantitative evaluation of future erosion trends, and guide future management.

Ongoing monitoring of any site rehabilitation should be incorporated into management plans, including ongoing removal of large woody debris, and revegetation of any deposits of dredged sediment.

5.0 Conclusions

The Detention estuary channel meander is a natural occurrence which deposits sediment at the inner curve and causes erosion at the outside of the curve of the meander (McKnight, 1996; Manahan, 2005) during both flood and ebb movements. Bank erosion on the outside bend is subject to channel dynamics in relation to a combination of sheer stress factors of catchment discharge, tidal currents and wave action, and sheer strength factors of sediment cohesiveness and lack of disturbance factors (Selby, 1992). Tree clearing in the upper catchment in 2004, uncharacteristically low annual rainfall in 2006 combined with easterly and north easterly wind directions may have contributed to geomorphic changes in the Detention channel dynamics. Now the meander is well established, it will continue to erode in a westerly direction.

Management mitigation of this erosion site must be approached with caution, and with ongoing monitoring. However, if management options are not wisely approached further erosion in the direction of Hellyer township infrastructure will most likely result.

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